

REMARKS

This amendment is provided in response to Paper No. 20090312. By way of this amendment claims 99 and 107, the only independent claims, have been amended, as well as dependent claim 102. Claims 106 and 111 have been canceled. Support for the amendments to claims 99 and 107 with regard to the plurality of metal particles exhibiting surface plasmon resonance is found throughout the application as filed and in particular Figs. 8-11 and paragraphs [0044]-[0047] and [0051]-[0056] of the U.S. patent application publication US 2006/0141268 corresponding to the above-referenced application. Support for the amendment to claim 102 is found in paragraph [0042] in the U.S. patent application publication US 2006/0141268 corresponding to the present specification. This paragraph details nanostructured silicon columns in a specific instance with respect to Fig. 1 that have a width of 20 to 30 nanometers and a height of 2,000 Angstroms (200 nanometers) As such, it is submitted that no new matter has been added to the application by way of this amendment.

Claims 112-115, which are directed to a nonelected group, are hereby canceled. Applicant reserves the right to prosecute the subject matter of claims 112-115 through divisional practice.

Currently, claims 105 and 107-111 stand rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement on the basis that the phrase “wherein one of said plurality of metallic nanocrystals bridges two spatially separated adjacent columns of said array of nanostructured silicon columns” is found to lack support in the originally filed specification. Additionally, claims 99 and 101-104 stand rejected under 35 U.S.C. §102(e) as anticipated by Filas et al. (US 6,741,019). Claims 99, 103 and 104 stand rejected under 35 U.S.C. §102(b) as anticipated by Sun et al. “Surface Reactivity of Si

Nanowires”, Journal of Applied Physics 89, 6396-6399 (2001). Claim 100 stands rejected under 35 U.S.C. §103(a) over Filas et al. in view of Debe (US 5,726,524) Claims 101 and 102 stand rejected under 35 U.S.C. §103(a) over Filas et al. Claims 99-102 and 104 stand rejected under 35 U.S.C. §103(a) over Debe. Claims 101, 102, 105, and 107-110 stand rejected under 35 U.S.C. §103(a) over Sun et al. in view of Zhang et al. (“Synthesis of Ordered Single Crystal Silicon Nanowire Arrays”). Reconsideration and withdrawal of these rejections is requested on the basis of the above amendments and the following remarks, and in particular with respect to the fact that the pending claims recite “an array of nanostructured silicon columns” and further that a plurality of metal nanocrystals form space uniformly between the columns and providing surface plasmon resonance.

**Remarks Directed to Rejection of Claims 105
and 107-111 under 35 U.S.C. §112, First Paragraph**

The basis for this rejection is a lack of support for the claim recitation of “one of said plurality of metallic nanocrystals bridges two spatially separated adjacent columns of said array of nanostructured columns”. In regard to this rejection, the Examiner’s attention is drawn to Fig. 6, the 90 second exposed film (lowest panel) that shows support for the offending language (as to “one of said plurality of metallic nanocrystals bridges two spatially separated adjacent columns of said array of nanostructured silicon columns”) that is further detailed in paragraph [0049] of the application publication.

In light of teachings found in the specification as highlighted above, reconsideration and withdrawal of the rejection as to claims 105 and 107-110 under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement is requested.

**Remarks Directed to Rejection of Claims 99, 101-104
and 106 under 35 U.S.C. §102(e) as Anticipated by Filas et al.**

Anticipation has always been held to require absolute identity between the claimed subject matter and teachings found within a single prior art reference with prior art elements being arranged as per the claim. Filas et al. is cited for teaching:

Silicon or semiconductor **nanowires** with diameters between 0.5 and 50 nms (col. 3, lines 1-15). As seen in figure 2b, the nanowires are coated with a magnetic material and drawn to a substrate in order to align the nanowires orthogonally to the substrate (nano columns) (col. 3, lines 18-55). A liquid carrier comprising nanoscale particles of metal such as Ag, Cu, Ni, Fe, and Au, are added to the magnetic coated semiconductor nanowires and deposited onto a substrate. The mixture is then decomposed, sintered or cured (col. 11, lines 1-30). The nanowires have lateral space alignment as seen in the figures (col. 9, lines 30-35).

(Paper No. 20090312, page 3, last paragraph) (emphasis added).

Claim 99 in current form recites “an array of **nanostructured silicon columns**” and “a plurality of metallic nanocrystals spaced **uniformly** between columns of said array of nanostructured silicon columns, said plurality of metallic nanocrystals exhibiting surface plasmon resonance.” (Emphasis added). It is respectfully submitted that both of these attributes of pending independent claim 99 are entitled to patentable weight.

In contrast to the pending claims, Filas et al. recites the use of a silicon nanowire and that a nanowire is not equivalent to an array of nanostructured silicon columns. Support for this position is found in the present specification at paragraph [0041] noting that an array of nanostructured silicon columns having an interconnected void network material are deposited with a high density plasma deposition tool. In contrast, Filas et al. details synthesis and use of nanowires at column 5, lines 39-65. Here it is noted that silicon nanowires are capable of being

formed with the geometric features comparable to the other materials, namely single wall nanotubes, which are not applicable to the claim language of a nanostructured silicon column, or multiwall nanotubes that tend to have sharp field concentrating tips useful for electron field emission. At column 3, lines 1-13, the referenced prior art methodologies for formation of silicon nanowires are detailed. Yet at lines 9-13 of column 3, Filas et al. states “However, whether such nanowires are capable of successful incorporation in field emission structures is not clear. (As used herein, nanowires indicates wires having average diameters ranging from about 0.5 nm to about 50 nm and aspect ratios of about 100 to about 10,000.)” To further emphasize the differences between the silicon nanowires of Filas et al. and the array of nanostructured silicon columns current being claimed, Filas et al. requires sharp tips on the silicon nanowires to facilitate electron field emission (column 5, lines 52-53) and notes an aspect ratio of such wires of about 100 to about 10,000. In contrast, paragraph [0042] in the present specification details nanostructured silicon columns in a specific instance with respect to Fig. 1 that have a width of 20 to 30 nanometers and a height of 2,000 Angstroms (200 nanometers) for an aspect ratio of height to width of between 6 and 10, namely at least an order of magnitude less than the smallest aspect ratio contemplated for a silicon nanowire according to Filas et al. On this basis alone, pending independent claim 99 and those claims that depend therefrom are submitted to be novel over Filas et al. Additionally, claim 102 has been amended to recite an “array of nanostructured silicon columns has a height of less than 2000 Angstroms and a columnar width of 20 to 30 nanometers” and therefore provide specific claim language corresponding to this argument.

Additionally, independent claim 99 now recites that the plurality of metallic nanocrystals exhibits surface plasmon resonance. As the magnetic coatings (reference numeral 14 of Filas et

al.) are continuous, any nanoparticles adhered thereto will not exhibit surface plasmon resonance, and as such this represents a separate basis for the novelty of claim 99 and those claims that depend therefrom relative to Filas et al.

Based on the above amendments and remarks, reconsideration and withdrawal of the rejection as to claims 99 and 101-104 under 35 U.S.C. §102(e) as anticipated by Filas et al. is requested. The rejection as to claim 106 on this basis is rendered moot based on the cancellation of this claim.

**Remarks Directed to Rejection of Claims 99, 103
and 104 under 35 U.S.C. §102(b) as Anticipated by Sun et al.**

The basis of this rejection is that Sun et al. teaches the use of silicon nanowires for their properties such as electron field emission as well as diameters of approximately 20 nanometers and that upon immersion in a metal salt solution comprising silver or copper, nanoparticles of metal are deposited on the sidewalls of the nanowires. (Paper No. 20090312, page 4, first paragraph). Here again, Applicant submits that independent claim 99, in reciting an array of nanostructured silicon columns and a plurality of metallic nanocrystals spaced uniformly between the columns to exhibit surface plasmon resonance, represents two separate bases for the novelty of this claim over the prior art.

Support for Applicant's contention that a silicon nanowire is not equivalent to nanostructured silicon columns is found in the sentence spanning the columns of page 6396 of Sun et al. where work with silicon nanowires is intended to parallel studies with porous silicon which is noted as being a sponge-like interconnecting network of silicon nanostructures. Additionally, nowhere does Sun et al. teach that silicon nanowires in fact form an array with an implicit ordering, nor does Sun et al. teach that copper or silver nanocrystals are either uniformly

spaced on the nanowires or exhibit surface plasmon resonance. As such, independent claim 99 and those claims that depend therefrom are now believed to be novel over Sun et al. The factual finding that “Sun does not teach a technique that will result in a densely packed array of SiNW’s.” (Paper No. 20090312, page 7, third paragraph) further supports the position that Sun et al does not anticipate these claims.

In light of the above amendments and remarks, reconsideration and withdrawal of the rejection as to claims 99, 103 and 104 under 35 U.S.C. §102(b) as anticipated by Sun et al. is requested.

**Remarks Directed to Rejection of Claim 100 under
35 U.S.C. §103(a) over Filas et al. in View of Debe**

The basis of the rejection is that Filas et al. is cited for the teachings detailed above with respect to the anticipation of claim 99, yet this reference is silent as to the substrate material and specifically the substrate being glass. Debe is cited for the use of glass as a substrate for field effect transistors (Paper No. 20090312, page 5, first paragraph).

Claim 100 is submitted to be allowable on the basis of dependency from claim 99, now believed to be in allowable form. Additionally, Filas et al. is submitted to be deficient with respect to the teachings detailed above regarding claim 99 and Debe fails to bolster these deficiencies. Debe fails to provide a teaching relevant to an array of nanostructured silicon columns nor a plurality of metallic nanocrystals spaced uniformly between nanostructured silicon columns so as to exhibit surface plasmon resonance.

Based on the above remarks, reconsideration and withdrawal of the rejection as to claim 100 under 35 U.S.C. §103(a) over Filas et al. in view of Debe is requested.

**Remarks Directed to Rejection of Claims 101
and 102 under 35 U.S.C. §103(a) over Filas et al.**

Reconsideration of this rejection is requested not only on the basis of the above remarks with respect to anticipation of these same claims under Filas et al., but also the simultaneous rejection of the claims both under 35 U.S.C. §102(e) and §103(a). While such rejections are appropriate in the alternative, simultaneous rejection of an identical claim under both bases is submitted to be improper. Additionally, with respect to claim 102, this claim has been amended to now recite a height of less than 2000 Angstroms and a columnar width of 20 to 30 nanometers to be consistent with the specification teachings with respect to Fig. 1 and define an aspect ratio that is more than an order of magnitude less than the minimal value called out by Filas et al. As such, Filas et al. is submitted to teach away from the subject matter of claim 102.

In light of the above amendments and remarks, reconsideration and withdrawal of the rejection as to claims 101 and 102 under 35 U.S.C. §103(a) over Filas et al. is requested.

**Remarks Directed to Rejection of
Claims 99-102 and 104 under 35 U.S.C. §103(a) over Debe**

The basis of this rejection is that Debe teaches an electric field emission device that includes a substrate with a dense array of discrete solid microstructures that are overcoated with electron emitting material, citing to the abstract. (Paper No. 20090312, paragraph spanning pages 5-6). Onto an array of microstructures, Debe is cited for providing an overcoat of electron emitting material of platinum (column 14). With respect to claim 99, the rejection continues:

However, this material [overcoating material] can be any of those materials instantly claimed (col. 12, lines 10-20). The coating nucleates into nanometer sized islands on top of and on the sides of the whiskers or nanorods (col. 13, lines 45-50, also see figures 2A-2C).

The process for coating includes dip coating (immersion) coating and electroless plating similar to those taught by the applicant (col. 13, lines 10-30).

(*Ibid.*, page 6, paragraphs 1 and 2).

Pending independent claim 99 recites “a plurality of metallic nanocrystals spaced **uniformly** between columns of said array of nanostructured silicon columns, said plurality of metallic nanocrystals exhibiting surface plasmon resonance.” (Emphasis added). It is respectfully submitted that Debe teaches away from uniformly spaced metallic nanocrystals between the columns of the microstructures and further, the efficacy of the structure produced according to Debe as an electric field emission device would make clear to one of ordinary skill in the art that the overcoating of platinum would not represent the isolated metallic nanocrystals necessary to exhibit surface plasmon resonance.

Reliance on the teachings found in Debe for materials other than platinum that can be utilized as an overcoating electron emitting material based on column 12, lines 10-20 is submitted to be improper on the basis that this recitation of materials found in Debe at column 12, lines 10-20 pertains to materials from which the microstructure itself is formed and not an overcoating thereon (see column 12, lines 4-5). Accordingly, reconsideration of this factual finding is requested. The factual finding with respect to Debe that coating nucleates into islands on the top of and sides of the microstructures is consistent with Applicant’s understanding of this reference, and the use of a vacuum coating method to so apply these materials (column 13, lines 51-65) is submitted to clearly teach a vacuum based coating method and recognizes the line of sight nature of such processes in that the deposition rate and incidence angle are relevant factors in nucleation and growth. Attention is directed to Debe column 14, lines 11-19 for a clear teaching away from the claim recitation of metallic nanocrystals “spaced uniformly between

columns of said array of nanostructured silicon columns” in that Debe teaches the effects of shadowing with the effect that coating gradient exists with the tops of the microstructures being preferentially coated at the expense of the microstructure bases. As such, it is respectfully submitted that Debe teaches away from uniformly spaced metallic nanocrystals along the length of the microstructure columns or, alternatively, that Debe fails to afford a teaching by itself, or in combination with the known prior art, that would lead one of ordinary skill in the art to produce uniformly spaced metallic nanocrystals between columns of a microstructured array.

It is a well established legal principle that to establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. In re Royka, 490 F.2d 981, 180 USPQ 580 (CCPA 1974). Additionally, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify or combine reference teachings. In re Rouffet, 149 F.3d 1350, 1357, 47 USPQ2d 1453, 1457-58 (Fed. Cir. 1998).

The outstanding rejection also cites to Debe column 13, lines 10-30 as calling out a process for coating of dip coating and electroless plating as being similar to those taught by the Applicant. (Paper No. 20090312, page 6, paragraph 2). In this regard, it is respectfully submitted that nothing in this section or anywhere in Debe teaches a composition consistent with the recitations found in independent claim 99 as to uniformly spaced metallic nanocrystals between columns of the array. Additionally, neither electroless plating or dip coating is known to one of skill in the art as providing uniformity in coating along the lengths of columns of a microstructured array. In fact, it is submitted that one of ordinary skill in the art recognizes these techniques to also preferentially deposit material proximal to the exposed microstructure surface with a deposition gradient away from the surface towards the microstructure bases. Debe

intrinsically exploits this gradient deposition of coating material on the exposed microstructure surface with a gradient extending from the surface towards the base to create high electric fields with these exposed surfaces. The effectiveness of the device produced according to Debe as a field emission device is respectfully submitted to be inconsistent with the surface plasmon resonance properties of uniformly spaced metallic nanocrystals of an inventive composition for this reason. The basic properties of surface plasmon resonance as it relates to an inventive composition are detailed in the instant specification at paragraph [0051]. As such, claim 99 is believed to be patentably distinct relative to Debe.

Dependent claims 100-102 and 104 are submitted to be in patentable form on the basis of dependency from claim 99, now believed to be in allowable form.

In light of the above remarks, reconsideration and withdrawal of the rejection as to claims 99-102 and 104 under 35 U.S.C. §103(a) over Debe is requested.

**Remarks Directed to Rejection of Claims 101, 102, 105 and
107-110 under 35 U.S.C. §103(a) over Sun et al. in View of Zhang et al.**

The basis of this rejection is that Sun teaches a method of making metal nanoparticles using silicon nanowires to reduce metal salt solutions so as to deposit the nanoparticles onto the nanowires as detailed with respect to the anticipation rejection “Sun uses SiNW’s that are fabricated by laser ablation techniques. Sun does not teach a technique that will result in a densely packed array of SiNW’s.” (Paper No. 20090312, page 7, third paragraph).

Zhang et al. is cited to bolster this deficiency of Sun et al. in providing a methodology that grows silicon nanowires of a higher density with equal weight, uniform diameter, and perpendicular growth (Paper No. 20090312, page 7, paragraph 4).

Applicant hereby incorporates by reference the above remarks with respect to the deficiencies of Sun et al. as applied to this prior art reference combination and notes that Zhang et al. fails to afford a teaching to bolster the deficiencies of Sun et al. with respect to a “plurality of metallic nanocrystals spaced uniformly between columns of said array of nanostructured silicon columns, said plurality of metallic nanocrystals exhibiting surface plasmon resonance.” Additionally, assuming for argument’s sake that the prior art reference combination of Sun et al. and Zhang et al. is formed as articulated in the outstanding rejection, the findings as to these references pertain to methodology and not to the compositions currently being claimed. Additionally, it is respectfully submitted that one of ordinary skill in the art would appreciate that by forming dense structuring of silicon nanowires with equal height, uniform diameter, and perpendicular growth, that these properties of the prior art combination device would hamper uniformly spaced metallic nanocrystal growth between the structures.

Based on the above remarks, claims 101, 102 and 105, which depend from claim 99, now believed to be in allowable form, are submitted to likewise be allowable.

With respect to independent claim 107, this claim recites the limitation of “a plurality of metallic nanocrystals where a single nanocrystal of said plurality of metallic nanocrystals bridges two spatially separated adjacent columns of said array of nanostructured semiconductor columns, said plurality of metallic nanocrystals exhibiting surface plasmon resonance.” The basis of the rejection with respect to this claim is again that Zhang bolsters the random direction silicon nanowire teaching of Sun et al. and instead teaches growth of perpendicular silicon nanowires with dense spacing and more uniform diameter and length. (Paper No. 20090312, page 9, paragraph 1). Based on Zhang et al., which is noted to nowhere teach surface decoration of so produced silicon nanowire array with metallic nanocrystals, it is stated that “one would

inherently and expectedly arrive at the instantly claimed structure wherein one of the plurality of nanoparticles bridges two silicon nanowires. [Citing to *In re Best*.]" (Ibid.) As Zhang et al. is wholly silent as to metallic nanocrystal application to an array, then findings as to a nanoparticle bridging two adjacent semiconductor nanostructured columns must be found in Sun et al. As Sun et al. teaches the necessity of removal of the oxide layer through HF etch to induce reduction of solution metal ions to form nanocrystals (page 6397, section B), then one of ordinary skill in the art upon attempting to grow metal nanocrystals would include the step and recognize that metal nanoparticle growth initiates at the interface between the semiconductor surface and the solution thereby creating a growing particle on a surface of a single semiconductor surface. This is in marked contrast to vacuum deposition or stranding preformed metal nanocrystals within an array. As such, the teachings of Sun et al., the only teachings relevant to nanoparticle growth, would lead one of ordinary skill in the art to recognize that nanoparticle growth occurs from a single contact point between the semiconductor and a metal ion solution that disfavors a single nanocrystal bridging two spatially separated adjacent columns of semiconductor material. Additionally, the newly added claim recitation that a plurality of metallic nanocrystals exhibits surface plasmon resonance requires that the metallic nanocrystals are separated from one another. This recitation disfavors the hypothetical argument that a single nanocrystal could be allowed to grow to a size such that it contacted an adjacent column as such growth would simultaneously lead to joinder with other metallic nanocrystals thereby imparting bulk metallic reflectance which is in direct contrast to the claim recitation as to surface plasmon resonance.

As such, with respect to claim 107 and those claims that depend therefrom, a single nanocrystal bridging two spatially separated adjacent columns of a nanostructured semiconductor array is respectfully submitted to neither be inherent or expected based on the combined

teachings of Sun et al. and Zhang et al. as they relate to claim 107 in current form. As claims 108-110 depend from claim 107, these claims are likewise submitted to be in allowable form.

In light of the above amendments and remarks, reconsideration and withdrawal of the rejection as to claims 101, 102, 105 and 107-110 under 35 U.S.C. §103(a) over Sun et al. in view of Zhang et al. is requested. In the event that this rejection is maintained, it is respectfully requested that it be stated with greater specificity as to the basis of single nanocrystal bridging being considered an inherent result of a prior art combination.

Summary

With entry of this amendment, claims 99-105 and 107-110 remain pending. The only independent claims, claims 99 and 107, have been amended as well as claim 102. Claims 106 and 111-115 have been canceled. Reconsideration and withdrawal of the outstanding rejections and the passing of this application to allowance are solicited. Should the Examiner have any suggestion as to how to improve the form of any of the pending claims, it is respectfully requested that the undersigned attorney in charge of this application be contacted at the telephone number given below.

The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 07-1180.

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Respectfully submitted,

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